

only correct if the Moon's R.A. is used in finding the longitude, as was the case with the plates of which the results are given above. Professor Turner has pointed out that if the Moon's place be left in standard coordinates, and not converted into R.A., it is possible so to select the coordinate axes that the refraction error would be eliminated in all cases.

Notes on Suitable Stations in Norway for Viewing the Total Eclipse of the Sun on 1896 August 8. By Colonel A. Burton-Brown, R.A., F.G.S.

It having come to my knowledge that some doubts had arisen as to the suitability of Norway as a post of observation for the total eclipse of the Sun in 1896, and having had both experience in total eclipse expeditions and of travelling in Norway, I thought I could not do better than spend my summer holiday in obtaining information that might be useful to Fellows of this Society and astronomers generally. Accordingly, I determined to make a special tour of observation both to the west coast, and also to Finmarken, Lapland, and the Russian frontier on the east coast. It was clear to me that some notes that had been published on the subject entered somewhat into the region of speculation, and might possibly in such an exceptional country as Norway, broken up into mountains and fjords, and where it was difficult to get trustworthy maps or guides, result in disappointment. Having, therefore, arranged to spend some weeks on this work, I started early in June for Trondhjem and the North, and have now the pleasure of laying before the Society the result of my observations. Since my return, in order to compile a suitable map to illustrate this paper, I wished to verify certain astronomical work, and I desire to express my thanks to Professor Turner and to Mr. A. C. D. Crommelin for useful notes and calculations, and in a very large measure to Captain Wesfel, of the Norwegian Artillery, who accompanied me in my journey through Finmarken, and whose knowledge of Lappish and Russian enabled me to penetrate far up the Tana River and other out-of-the-way parts amongst the Finns. My own knowledge of the languages, and of Laplanders' and Norwegian manners and customs, also stood me in good stead. I had previously found that on travelling out of the beaten track very little dependence can be placed on guide-books—even the usually reliable Baedeker is full of errors—and this made me more anxious that astronomers taking part in this expedition, especially as some of the posts would be found in isolated and more or less un-get-at-able spots and difficult of communication, should not be led astray in this matter. Statements having approximate truth may be good enough for ordinary tourists, but yet utterly insufficient for the careful work of an observer of an eclipse expedition.

It appeared to me that in selecting stations in such an exceptional country as Norway, many points must be considered that do not apply to most places; thus it is not enough to know that A is twenty miles from B without also knowing how many fjords lie between, how many peaks three or four thousand feet in height, how many glaciers, and how far they are crevassed, if the mountains are passable, and if so what weight besides himself a man can carry up. Those people who have visited Norway, and the more so those who have travelled in the interior and north of the country are surprised at the almost impossibility of moving at all except by the fjords and certain made roads. These generally may be said to extend as far north as Trondhjem, lat. $63^{\circ}26'$; long. $10^{\circ}30'$ about. After that, on the north and north-east coast and Russian frontier, roads are the feeblest tracks generally, and the fjord communication only of a special character; the population, except at such places as Tromsø, Hammerfest, Vardo, and Vadso, is very scanty, and chiefly confined to the sea coast, and in the latter case subject to considerable variation, according to the season of the year and the nature of the fishing. How far these points would affect an astronomical expedition will be seen later on. It became necessary to divide my tour of observations into two parts: first, the easy part, on the west coast, the less valuable from an astronomical point of view, but which should not be disregarded, and which we may call the pleasure trip; and second, the difficult but more valuable part, on the N.E. of Norway.

Leaving Trondhjem, we take a N.N.E. course, passing Torg-hatten, an island of about 800 feet in height, and shortly after pass the Island of Donnæsø, at the bottom of the map‡ on the west side, where we should be on the border of the shadow during totality; steaming north to Tommen Öe, which will have about one minute totality, a careful search for stations is kept. Lüröe is too low, Oxtinden Promontory too much inland. We reach Hestmandöe,* well within the 85 sec. line, and the Island of Tränen, near the 12th parallel, too far west, though the central line passes close by; but having a longitude of only $12^{\circ}5'$, the Sun is rather low. Height of ground, 3710 feet. Röd Löven† also, somewhat further eastward, and Bolgen, a peaked island, close to the central line, but rather too far westward; passing Omnæs Öe and Melöe, crossing the central line, we next round the Promontory of Kunnen, two or three miles above the central line, a rather inaccessible position of some 2000 feet high. The lighthouse Island of Slöt is, however, in all respects a desirable position, and Kunnen has a telegraph station—a valuable adjunct. Proceeding E.N.E. we pass the Island of Fuglöe, 2300 feet high,

* To illustrate the inaccuracy of guide-books, one gives Hestmandöe, through which the Arctic Circle passes, as $66^{\circ}50'$, another, $66^{\circ}20'$; a question of importance to astronomers.

† Röd Löven marked Rodö on map.

‡ See Plate 2.



steep and rugged, and $1\frac{1}{2}$ miles further north Fleina, about 400 to 1000 feet—a good position. On the right is the Island of Sandhorn, with the Sandhornet Mountain of 3300 feet—a rare position for our mountaineers, only about five or six miles above the central line, with a minute and a half totality, and the Sun an altitude of $7\frac{1}{2}^\circ$ about, the longitude being six or seven minutes over 14° . This position gives an uninterrupted view all round. For non-climbers the Arnöe Islands on west, where there are fishing stations, would afford an almost equally good position. These places are in easy communication with Bodo, whose lat. is $67^\circ 17'$, and long. $14^\circ 24'$ about, and which is ten miles direct north of the central line, where there is a hill to the N.E. of the town. Here excellent accommodation can be had, and a telegraph station exists. Further north is the Island of Lande Gode, within the 85 sec. limit. The Islands of Lundo and Engelo are on the northerly limit of the shadow of totality, and therefore useless. It seems to me that if Bodo was occupied as headquarters, with a steam launch at the disposal of the party, and Sandhornet, Arnöe, Fleina, Kunnen, or the lighthouse rock of Slöt, Bolgen, Röd Löven, or Hestmandø as detached stations, a valuable area would be covered, although these positions have the astronomical disadvantage of the Sun's altitude being as low as $6\frac{5}{8}^\circ$ to $7\frac{3}{4}^\circ$, and the duration of totality but little over $1\frac{1}{4}$ to $1\frac{1}{2}$ minutes. Yet, owing to the stillness of the atmosphere on the west coast of Norway at that time, and the general freedom from clouds on the horizon, some good results should be obtained. The further fact of the corona being seen through a considerable thickness of watery vapour would have both a spectroscopic and photographic interest *in comparison with similar observations taken at about double the altitude on the east coast*. The way to work this tour would be to take the ordinary Norse mail-boat from Newcastle to Trondhjem, *viâ* the Fjords, arriving at the end of July; thence take the steamer to Bodo; or if it is wished to extend the tour to the North Cape, a start of a week earlier must be made, and steamers changed at Hammerfest, or arrangements made to be disembarked at Bodo coming south; or a steamer might be taken direct, slowly steaming over the central line and back. Although I have marked several islands in black on the map, my experience has shown some to be better adapted for many reasons than others. Thus Fugløy is steep and rugged, and has no advantages over Fleina except height; also Omnæs Øe is a troublesome place; Kunnen is an almost inaccessible promontory of chert and granite rocks; the Island of Slöt has a good anchorage for boats, and the Sun would not be masked by Kunnen during totality. Here also is a telegraph station.

Röd Löven and Omnæs have the disadvantage of being either east or south of those mentioned, and Bolgen, though well placed, would afford a steep and difficult climb. I have attached a map (see Plate 2) compiled from six or seven different English, French, Norwegian, Swedish, Russian, and other maps and charts,

reduced from the large scale one of $3\frac{1}{7}$ inch to a mile [shown at the meeting], and I have entered on it the most suitable stations both on the east and west side of Norway. The shadow is shown as extending from 12° to 32° longitude east of Greenwich, and the line of 1^m duration N. and S. of the central line (dotted) is also marked, the maximum totality on this central line increasing from 91^s to 104^s as we move eastward.

[The photographs handed round I must apologise for, as some are indifferent; but they will help, as will also the sketches, to illustrate and explain the paper.] I would now like to caution astronomers against guide-books, which are only suitable for casual travellers and those with ample time at their disposal; real information must be obtained from really good maps (difficult to get) and from people who have been on the spot and know what is required. Even that excellent guide "Baedeker" is more or less a fairy tale, and such astronomers who believe good accommodation is to be got at out-of-the-way places because a guide-book says so, may be sorely disappointed, as I have had the inconvenience of learning practically. Further, heights and distances from those sources must be received only as approximate. The writers of an interesting little paper suggest a station on the top of Sulitelma (see map and photo). As this would involve a special steamer up the Fjord from Bodo (or a still more difficult journey over lands and rivers), some eighty miles distant, several changes of conveyance, and four changes of boats to get to the bottom of the peak, then three or four days over glaciers and snow, on which journey all provisions would have to be carried, and even fuel and tents, part of the way, I cannot agree in thinking it neither dangerous nor very fatiguing, and I speak from mountaineering experience over 17000 feet high in the northern Himalayas. Norway is not open to tourists as Switzerland is, and before such an expedition is undertaken a course of mountaineering and arctic work should be undergone. Furthermore, no instruments of any size could be carried, and when once the peak is reached, the chances are ninety-nine out of a hundred that it would have its night-cap on, and no sun would be seen from it at all. This latter remark applies to all high mountains in Northern Norway, which have more or less snow on them, and are in the vicinity of glaciers. Thus the Bugönæsfjeld, for instance, near Vadso. If there is moderately high ground on islands such as I have mentioned, they are generally clear, but inland the reverse is the case. This year was quite an exceptional one, yet some of the photographs show clouds at or near the peaks. It may interest astronomers to hear that the "midnight sun" on July 9 in lat. 70° and long. about $18^\circ 10'$ was *perfectly* free from cloud. The temperature in its direct rays was 56° F., in the shade $52\frac{1}{2}^\circ$ F. (or only $3\frac{1}{2}^\circ$ F. diff.): its apparent altitude was about 5 diameters, and with a $2\frac{1}{2}''$ object glass it would not burn paper, and only charred it in the focus of a 4" glass, and the lines of moisture in the spectroscope were strongly marked. But to pass on: leaving

the west-coast positions, we reach Tromsø, and steaming up to Hammerfest signs of civilisation die fitfully away. The coast is bleak and barren. On reaching Hammerfest we see the spot where a late President of the Royal Society, General Sir Edward Sabine, R.A., carried on his Pendulum Observations in 1823, and where a conference of astronomers of Norway, Sweden, and Russia on their labours from 1816 to 1852 fixed the northern termination of the $25^{\circ} 21'$ meridian from the Arctic Ocean to the River Danube. Here we probably change steamers and round the North Cape, $71^{\circ} 10' 40''$ N., and about 26° E.; steering east we pass the Nordkin, and from there in a S.E. direction along a bleak, inhospitable shore of quartzite rocks to Vardo, on an island, this is about the N.E. corner of Norway, a good sized whaling station, and a fort, with some second-class hotel accommodation. The high ground here would do for an encampment, or at least that portion not occupied with fishing lines and dried or, still worse, drying fish. This place was used as an observing station in 1769 by the Austrian Hell for the transit of Venus; and, being less than twelve miles directly north of the central line of shadow, might be advantageously occupied. It forms the most easterly station; being in long. $31^{\circ} 8'$, and lat. about $70^{\circ} 22'$, it would have a duration of totality of over $1^m 31^s$, and the Sun's altitude of about $14\frac{1}{2}^{\circ}$. It is easily get-at-able, no high ground obstructs the view, and provisions and labour are to be had. Passing south down a dreary coast of quartzite rocks and Silurian slates, we come to Kilberg, about ten miles south, and two miles inland. There is a hill about 500 feet high, but although this would be only five or six miles north of the central line, it is not in other respects a desirable station. Steaming S.S.W. we pass Store Ekkero, a promontory some twenty-five or thirty miles west of Vadso, which appears to have all the attributes of a good station, provided accommodation can be arranged for: the central line of totality passes over the southern point, and there is a free view to the S.S.E. and E.N.E., the Sun's azimuth at the local time of 18^h being 97° south towards east, and the duration of totality a maximum—viz. over $1^m 41^s$, the Sun's altitude about $14\frac{1}{4}^{\circ}$. Passing on to Vadso, the town of the Finmarken district, there are several hills, two or three hundred feet, easily accessible, and in all respects suitable for observing stations within three or four miles; indeed, Vadso should be looked upon as the headquarters of an East Norway expedition. The local time of totality here would be $17^h 57^m 46^s$, and duration about $1^m 35^s$. All the aforementioned places are in telegraphic communication with most parts of Norway during the fishing season, and I have no doubt arrangements could be made for keeping the offices open as late as August 8. The temperature at Vadso is remarkably high, probably between 50° and 60° F. in August (I have known it in the early summer to be 90° F.), and from statistics and all I can learn locally, I think there is every chance of fine weather at that time. I have already paved the

way for an expedition here, and instructed a number of Norwegians in the neighbourhood.

Crossing the Varanger Fjord we come to Bugö, a Lapp fishing station, and within a mile and a half of the central line: the longitude is about $29^{\circ} 50'$, and latitude $69^{\circ} 58'$. Here the duration would be about $1^m 40^s$, with nothing to obstruct the view; frequent communication could be had with Vadsö at certain times of the day; heliograph signals might be transmitted; there are several sites hereabouts, but one in particular desirable. Baedeker's suggestion, however, that good quarters may be had anywhere hereabouts reads like a fairy tale, and is a pure fiction. But no doubt if arrangements were made beforehand, a structure might be obtained or a place run up. The Bugönäsfjeld I will leave to those who like to be in the clouds! So little is known of it that every map shows it in a different position; but if intrepid mountaineers are fond of carrying half-hundred-weights up mountains, there is no reason why they should not have the satisfaction they desire, but they will find no one to do it for them.

In order to distribute the parties and multiply the chances of success, I would suggest some one party proceeding from Vadsö to Seida, on the Tana River. This station is a good one for all points except the length of totality, which is only about $1^m 12^s$, and has the Sun at an altitude of about $13\frac{1}{2}^{\circ}$. Polmäk, some 12 miles due south (reached by poling up the river), is not so easily got at, but astronomically better situated, and S.E. of it, about five miles, is a mountain over 1000 feet high; but time did not enable me to explore it. About forty or fifty miles further up this river, in a S.W. direction, is Utsjoki, a place also that might be advantageously occupied in the Russian Lapland. The duration of totality here would be about $1^m 26^s$, and the Sun's altitude about 13° ; both at Polmäk and Utsjoki camp equipage would have to be taken. Both are in telegraphic communication with Vadsö and Vagge, the latter place being at the mouth of the Tana Fjord. Karasjok is astronomically a good place, within four miles of central line, the Sun's altitude being about $12\frac{1}{4}^{\circ}$ and duration of totality over $1\frac{1}{2}^m$. Much, of course, will depend on the number of observers it is proposed to send out, their powers of endurance, and knowledge of Lappish, Russian, and Norwegian for the east coast expeditions (except at Vadsö).

If ladies purpose joining, I would recommend them to go to Bödo, on the west side, or Vadsö, or possibly Vadsö, on the east coast, on account of the accommodation at the first and third places. I think it might be possible to arrange with the mail steamboat companies to live and feed on board ship (which in this case would be changed every third day) during their entire stay at Bödo or Vadsö. I have already been in negotiation with the steamboat companies on this subject. In any case, the lines of communication would be carried out best

by the Norway company's steamers for an eastern expedition, and probably for a western also. (It is quite unnecessary to consult Cook or Gaze on the subject, which would mean an extra cost of 10 or 15 per cent., and it can be done well without.) The Norse steam companies would doubtless also provide a steam launch, and fuel, to keep up communication between the various parties. With proper care and organisation, I think we have every reason to expect that success should crown our efforts; the weather in all the parts I have referred to is likely to be favourable, and the hardships not to be too great for those energetic women who help us everywhere to success. Yet they must be self-reliant in these out-of-the-way districts, and be ready to put up with inconveniences, mosquitoes amongst other pests being plentiful, and rendering one's couch not always a bed of roses.

This eclipse is also visible in Japan, on the Island of Yezo, the duration of totality being longer, and the Sun's altitude greater considerably; and observations on this station I shall be happy to refer to at a later period.

Total Eclipse of the Sun, 1896 August 8.

Table of Advantages of Suggested Stations.

Names.	Lat.	Long.	Totality.	Di-stance C. Line	Altitude of Sun.	Lodging accom- modation.	Feeling.	Height. Suitable positions.	Description.	Telegraph Station.	Weather.	Com- munication.	Remarks.
			m s.	Miles.	° '			Feet.					
Tommen Öe	66 15'	12 50	1 10	S. 28	...	Nil	...	...	Island	...	Fair	Difficult, S.	See note (a)
Trenen	66 30	12 05	1 31	S. 2	6 21	Nil	...	2000	Island	...	Good	"	
Oxtinden	66 26	13 11	1 16	S. 24	...	Nil	...	...	Promontory	Yes	Fair	Good, S. Grono, a steam- boat station	
Hestmand Öe	66 31	12 50	1 25	S. 11	6 40	Fishing	Take some	1700	Island	Near	Good	Fair, S.	
Næsöe	66 35	12 40	1 23	S. 6		Unknown	...	...	Island	...	Good	Good, S.	
Röd Löven	66 42	13 08	1 28	S. 6		Fishing	Arrange	1200	Island	Near	Good	Good, Grono	See note (b).
Bolgen	66 48	13 13	1 29	S. 2	to	Nil	Arrange	700	Island	...	Good	Good, Grono	
Meiöe	66 49½	13 28	1 27	S. 4		{ at Grono } (near)	Take some	2000	Island	...	Good	Good, Grono	
Kunnen	66 56½	13 33	1 28	N. 3		Yes	Take some	2000	Promontory	Yes	Good	Good, Bödo	
Sjöt Öe	66 57½	13 31½	1 27	N. 4	7 16	Lighthouse	Take some	125	Lighthouse	Ö	Yes	Fair, Bödo	
Fuglöe	67 03½	13 50	1 24	N. 7	...	Fishing	Arrange	1200	Island	Near	V. Fair	Good, Bödo	
Fleina	67 06	13 55	1 22	N. 10	...	Fishing	Take some	400	Island	Near	Good	Good, Bödo	
Sandhornet	67 06	14 06	1 23	N. 5	...	Yes	Take some	3300-4000	Island	Yes	Good	Easy, Bödo	
Bödo	67 17	14 24	1 21	N. 10	7 45	Very Good	Good	50-400	Neck of land	Yes	V. Fair	Station	

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Names.	Lat.	Long.	Totality.	Distance C. Line.	Altitude of Sun.	Lodging accom- modation.	Feeling.	Height. Suitable positions.	Description.	Telegraph Station.	Weather.	Com- munication.	Remarks.
	° ' "	° ' "	m s	Miles.	° ' "			Feet.					
Lande Gode	67 23	14 20	1 27	N. 17	7 44	Unknown	Arrange	500	Island	No	Good	Fair	Beieren Hill, 4000 feet, near Bödo
Vardo	70 21½	31 08½	1 31	N. 10	14 40	Fair	Good	50-150	Island	Yes	Good	Good	
Kilberg	70 16	31 06	1 35	N. 6	14 35	Indifferent	Arrange	350	Promontory	Yes, near	Good	Good	Sandstone rocks
StoreEkkero	70 05	30 10	1 41	N. 1	14 12	Fair	Arrange	50	{ Mainland & } promontory	Yes, near	Good	{ By road, Vadso }	
Vadso	70 04	29 47	1 35	N. 5	13 41	Good	Good	250-450	Mainland	Yes	Good	Good	
Bugönæs	69 58	29 50	1 40	S. 1½	13 40	Tents	Arrange	50	Promontory	Heliograph	Good	{ Good f. } { Vadso }	Lapp & Finn
Seida	70 15	28 10	1 12	N. 23-27	13 25	Fair	Arrange	200-300	Inland, Hill	Yes	V. Good	Good	Mosquito tents required ; mountain
Palmäk	70 02	28 05	1 21	N. 16	13 23	Fair	Arrange	100-1000	Inland, Hill	Yes	V. Good	Fair	1000 ft., near Seida; 3 sec.
Utsjöki	69 45	26 48	1 27	N. 13	13 00	Tents	...	150	Inland	...	Good	Difficult	longer to- tality
Karasjok	69 15	24 40	1 31	S. 4	12 20	Unknown	...	200	Inland	...	Fair	More difficult	

(a) S. means Sulsovig, a steamboat station.

(b) In col. 8 "Arrange" means that feeding may be arranged for in part on the spot; "Good" means that Good feeding may be obtained there. Throughout the table the sign ... means "uncertain."

On the Measurement and Reduction of the Plates for the Astrographic Chart. By Professor H. H. Turner, M.A., B.Sc.

1. In a former paper (*Monthly Notices*, liv. p. 11) I briefly indicated a method of rectilinear coordinates, by which the reductions of measures on photographic plates could be made with comparatively little reference to spherical coordinates of any kind, especially the coordinates R.A. and Declination, and thus with very much greater simplicity and rapidity than by other methods. The method is specially applicable to the comparison of one photographic plate with another; and in this case the introduction of R.A. and Decl. as a medium of comparison simply entails a very large amount of waste labour. For the comparison of a photographic plate with existing meridian or other observations, we naturally cannot escape dealing with R.A. and Decl. at some stage; but it seems to me that, in view of the fact that the number of stars with which we shall deal photographically will probably enormously exceed the number to be dealt with in other ways, the transformation should be rather that of the comparatively few existing measures of R.A. and Decl. into rectangular coordinates, suitable for comparison with photographic measures, than of the numerous photographic measures into R.A. and Decl.

2. In a subsequent paper (*Monthly Notices*, liv. p. 489) I gave an example of such a transformation of R.A. and Decl. into suitable rectangular coordinates, whereby the measures of a number of plates of the *Pleiades* could be "reduced"—signifying by the term "reduction" the correction for errors of orientation, scale value, refraction, aberration, &c.—with very little labour. The Astronomer Royal and Mr. Dyson gave last month (*Monthly Notices*, lv. p. 60) an example of the facility with which four photographic plates could be compared *inter se*. I have also been privileged to see a paper which Captain Hills is communicating to the Society this month on the determination of longitudes by photographs of the Moon and stars, in which he expresses very kindly his indebtedness to the method of rectilinear coordinates for reducing photographs. Perhaps it is not too much to hope that, as its advantages become better known, the method of rectilinear coordinates for reducing, and *expressing the results of*, photographic measures will be generally adopted.

3. The object of the present paper is to give at greater length detailed directions for measuring and reducing the plates of the Astrographic Chart in accordance with the principles of this method. Much experimental work has been done both at the Royal Observatory, Greenwich, and the University Observatory, Oxford, the results of which it seems advisable to set down for the criticism, or the information, of others. It is quite probable that improvements may yet be suggested in various directions;